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American Potato Journal

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INDUSTRIAL UTILIZATION OF CULL AND SURPLUS POTATOES

R. H. TREADWAY

Eastern Regional Research Laboratory, Philadelphia, Pa.*

Efficient utilization of cull and surplus potatoes presents many difficulties. Culls, which constitute from 5 to 15 per cent of the annual crop, create a utilization problem each year, and this is magnified by the occasional surplus crop. The problem of surplus potatoes was made unusually conspicuous by the record crop in 1946. Since the consumption of potatoes as a food does not vary appreciably with fluctuations in their availability and price, outlets for surplus potatoes must be sought through industrial utilization.

The yield of potatoes increased from an average of 126 bushels per acre in the 1935-1944 period to 155 in 1945 and an all-time record of 184 in 1946. The 1946 crop was grown on the smallest acreage planted since 1892, and the 1947 crop was planted on a still smaller acreage (Table 1).

Several factors are responsible for the huge potato surpluses of 1943 and 1946. During the war, it was necessary to produce an enormous amount of food, requiring maximum agricultural efficiency. There was a switch from low-yielding to high-yielding areas. Chemical fertilizers were applied more commonly and in greater amounts than ever before. Improved insecticides were introduced; widespread use of DDT for the first time is generally believed to have been instrumental in developing the record potato crop in 1946. Finally, the ideal weather of the 1946 season played an important rôle.

TABLE 1 *Acreage, yield, and production of potatoes in the United States from* 1935-1947*

Year	Acreage Harvested	Yield Acre	Production
	1000 acres	Bushels	1000 Bushels
1935	3,469	109.2	378,895
1936	2,960	109.4	323,955
1937	3,055	123.2	376,448
1938	2,870	124.0	355,848
1939	2,813	121.7	342,372
1940	2,832	133.1	376,920
1941	2,693	132.1	355,697
1942	2,671	138.1	368,899
1943	3,239	141.7	458,887
1944	2,786	137.6	383,424
1945	2,700	155.1	418,765
1946	2,580	184.5	475,969
1947	2,190	168.1	379,886

*Source: U. S. Department of Agriculture, Bureau of Agricultural Economics.

Industrial utilization of surplus potatoes is difficult because of the uncertainty of supply. Moreover potatoes are perishable, and must be processed within a limited time after harvesting. Since potatoes contain about 80 per cent water, transportation is expensive, and handling costs are high. Other principal crops which sometimes are harvested in surplus, for example, corn, wheat, cotton, and tobacco, can be put into storage at ordinary temperature without processing, and thus can be saved to offset a lower yield of a following year. But potatoes that are not kept in cold storage or preserved by some other treatment will sprout, which destroys not only their appearance as a food product but also much of their carbohydrate constituents.

Stated broadly, the problem of utilizing cull and surplus potatoes can be solved or alleviated by (a) developing new non-food outlets, preferably profitable, for fresh potatoes, (b) by improved methods for converting potatoes into stable forms to permit storage for utilization later as food, feed or industrial raw materials, and (c) developing efficient and economical methods of storing fresh potatoes. Because of the many disadvantages involved in dumping potatoes, probably it is preferable in some instances to divert surplus potatoes into industrial channels without profit or even at a slight monetary loss.

*One of the laboratories of the Bureau of Agricultural and Industrial Chemistry, Agricultural Research Administration, United States Department of Agriculture.

Current Outlets for Cull and Surplus Potatoes

Several well-established outlets now exist for diversion of cull and surplus potatoes from the regular table stock market. Potatoes are used in food-processing industries, livestock feeding, starch production, alcohol production, and in smaller miscellaneous outlets. Beginning in 1937 and continuing during surplus crop years, the U. S. Department of Agriculture has operated diversion programs under which industrial users of surplus potatoes obtained them at low cost.

Starch Production.—Utilization of potatoes for starch production is perhaps the oldest industrial use. Early in the history of the potato starch industry, potatoes of high starch content were grown specifically for this purpose. Much of the total starch produced in the United States during the first half of the nineteenth century was made from potatoes. Late in the last century there were about 150 potato starch factories in Maine, New Hampshire, Vermont, Ohio, Michigan, Wisconsin, and Minnesota. After about 1880, the production of potato starch decreased because of the rise of the cornstarch industry and also because the improvement in transportation made it profitable to grow and move more table stock potatoes to distant markets.

Cornstarch was first produced in 1842 and rapidly became the principal starch since it was soon apparent that potato starch could not compete in price. Potato starch then became a specialty starch and retained this position regardless of its higher price. Aroostook County, Maine, became the center of the potato starch industry, the starch factories forming an outlet for cull and surplus potatoes. About 20 factories now operate in Maine, with a total capacity of approximately 50 million pounds a year. Four starch factories established in Idaho in 1941 can produce about 30 million pounds of starch annually. More recently still, a cooperative established a potato starch factory in Lynden, Washington, where the starch is converted to glucose. If all the starch factories in the country operated at capacity for a 200-day season, 10 to 15 million bushels (2½ to 4 per cent of the total production) of potatoes would be consumed. Table 2 shows the amounts of potatoes consumed in starch manufacture and the quantities of starch produced annually from 1930 to 1945.

The daily capacity of existing starch plants ranges from 5 to approximately 25 tons. A starch factory which produces 5 tons of starch per day for a 200-day operating season needs approximately 300,000 bushels of potatoes. It should preferably be located in a region where potatoes can be stored and where an abundant supply of good water is available. Because the raw material cannot be kept in ordinary stor-

TABLE 2 *Quantities of potatoes used and potato starch produced in the United States from* 1930 *to* 1945*

Crop	Potatoes Used for Starch Manufacture 1000 Bushels	Computed Quantity of Starch Produced (1000 pounds) (On basis of 7.27 Pounds Starch per Bushel)
1930	1,662	12,088
1931	2,554	18,574
1932	1,343	9,768
1933	1,399	10,174
1934	5,319	38,684
1935	1,475	10,728
1936	1,834	13,338
1937	3,680	26,764
1938	2,932	21,324
1939	2,699	19,630
1940	8,030	58,400
1941	4,892	35,578
1942	3,308	24,078
1943	10,050	72,112
1944	4,005	29,124
1945	5,682	41,320

*Source: Potato Division, Fruit and Vegetable Branch, Production and Marketing Administration, United States Department of Agriculture, Washington, D. C.

age during the summer, potato starch factories seldom operate more than 8 months of the year, from about 1st of October to the 1st of June. In addition to the short operating season and uncertain supply of raw material, the problem of disposing of starch-factory wastes, which has become increasingly important in recent years because of the movement to eliminate stream pollution, has been a drawback. The fact that potatoes for industrial processing cannot be economically transported great distances has favored the plan of locating small factories throughout a high production area, for example, Aroostook County, Maine, instead of the establishment of a few, centrally located, larger plants.

The Green Mountain variety of potato formerly constituted a high percentage of the total supply grown, but in recent years there has been a trend in Maine toward the production of Katahdin, Sebago, Chippewa, and other varieties which contain less starch but are more disease-resistant. This switch to potatoes of lower starch content has discouraged expansion of the potato starch industry in Maine.

In processing potatoes for starch recovery, the methods in general consist of grinding the washed tubers to a pulp, screening the fibrous material from an aqueous starch suspension, removing impurities from

the starch, and drying. A starch factory which extracts 85 per cent of the available starch in potatoes is considered to be relatively efficient. Thus 100 pounds of potatoes containing 13 per cent starch, about the average for the varieties now grown, will yield about 11 pounds of dry starch or approximately 13 pounds of starch containing 17 per cent moisture, the average for commercial potato starch. Potato starch currently brings the factory 8 cents per pound which accounts for a gross return of $1.04 from 100 pounds of potatoes. No reliable manufacturing cost data are available, but total costs are estimated at 1 to 2 cents per pound of starch. It is evident that, after manufacturing costs are taken into consideration, the price which may be paid for the raw material is much less than the selling price of table stock potatoes.

Potato starch is used principally in the textile mills of New England and the southern states for sizing cotton, spun rayon, and worsted warps. It is also used to a less extent as such and in the modified form of dextrin in adhesives, in paper sizing, in the baking industry, in fine laundering, and as a thickening agent for various applications.

Prior to World War II, potato starch was regularly imported from the Netherlands to supplement a deficient supply of high-grade domestic starch. The construction of modern plants in Maine and Idaho in the period 1938-1941 and the improvement in manufacturing operations resulted in a domestic supply of high-quality starch which satisfied the most essential needs during the war and postwar period. The potato starch industry appears to be firmly established, and a modest expansion could probably take place without saturating the market.

Food Processing.—The *per capita* consumption of potatoes has markedly declined during the past 35 years or so (from 197 pounds in 1910 to 126 pounds in 1946). This trend has been attributed to various factors, such as (a) increasing competition of other vegetables, both fresh and frozen, which are available throughout the year in attractive forms; (b) gradual rise in the economic level of the average American, with the accompanying ability to purchase a greater variety of the more expensive vegetables; and (c) the erroneous conception that potatoes are more fattening than other carbohydrate foods. The decreased consumption of potatoes might be due also to the fact that the population shift from rural districts to urban centers has resulted in a demand for foods which involve less preparation than is entailed in peeling and cooking potatoes. The consumption, therefore, might rise if potatoes were processed into forms which are either ready to eat or readily prepared for the table. In any event, in recent years there has been an increase in the amount of potatoes going into pro-

cessed foods, and this trend may in part offset the lower consumption of potatoes in the ordinary form.

Among food products made from potatoes, chips occupy a prominent place. Potato chips have been produced for many years, but only in the last 10 to 15 years has the industry grown to large proportions. In 1946, 15.4 million bushels of potatoes were processed into 243.6 million pounds of chips, an average yield of 25.8 pounds of chips per 100 pounds of raw potatoes (5). The average *per capita* consumption in 1946 was 1.8 pounds of potato chips. The shortages of vegetable fats and processing machinery during the war retarded expansion of the potato-chip industry, but with the current improvement in these supplies further expansion is anticipated.

In producing chips, clean, peeled, potatoes are sliced thin, washed and drained to remove loose starch granules, and then fried in oil. Certain varieties of potatoes are better for making chips than others, but an important factor, regardless of variety, is the so-called reducing sugar content of the potatoes (2). Chips produced from potatoes containing an appreciable amount of reducing sugars are dark and relatively unpalatable. Freshly dug potatoes are generally low in sugar content, but they accumulate sugars in cold storage. If such potatoes are kept at approximately 60° to 70° F. for several weeks, however, the sugar content is reduced. Inasmuch as chips sell for a good price and potatoes of a certain type must be used, potatoes intended for chips bring a premium above that of ordinary table stock.

Potato flour seems to have been the first processed potato product to reach quantity production. It was produced in the United States during the first World War as a substitute for wheat flour. In producing flour, the potatoes are peeled, generally cooked, dried, and then ground to a powder or meal. Potato flour is used in admixture with wheat flour in the baking industry, as a "breading" agent for meats, poultry, and vegetables, as a thickening agent in soups and sauces, and as an extender in sausages, meat loaf and scrambled eggs. About 20 million pounds of the flour are produced annually, requiring about 1¾ million bushels of potatoes. Most of the potato flour is produced in four factories in Idaho. Other plants are located in Michigan and Minnesota. Although potato flour is evidently well established in its limited market, the growth of the industry has been rather slow.

A recent development in the merchandising of potato flour consists of a blend of the flour with dehydrated onions and seasoning to comprise a potato pancake mixture.

In addition to potato chips and flour the food processing industry also produces dehydrated potatoes, canned potatoes, potato soup, and

potato salad, fast-frozen preparations, and peeled fresh potatoes. During World War II, a considerable tonnage of potatoes was dehydrated, chiefly for shipment to the armed forces. The potatoes were diced, riced, shredded, or granulated and then dehydrated in either the cooked or blanched, uncooked form. At the end of the war, most of the manufacturers stopped their operations, but a few have continued in the field and now turn out a dehydrated product which, after proper reconstitution, is difficult to distinguish from freshly cooked mashed potatoes.

Potatoes have been canned to some extent in the last few years. Generally, whole, peeled potatoes of small size are used for this purpose. French-fried, sliced, diced, and julienne potatoes, potato salad, and potato soup are also canned.

Frozen French-fried potatoes have been placed on the market recently. It is also reported that raw sliced potatoes are being fast-frozen.

Potato-peeling plants have been established in several large Eastern cities. This industry delivers peeled ready-to-cook potatoes to restaurants, hotels, and other large consumers.

Livestock Feeding. For many years, cull potatoes have been fed to livestock on the farms where the potatoes were grown. This is probably the most economical utilization of cull potatoes, since no transportation or processing is required. As a rule, the potatoes are cooked if they are to be fed to hogs, but raw potatoes, usually chopped or ground, are fed to sheep, dairy cattle, and horses. Perhaps 5 per cent of the annual crop of potatoes is disposed of in this way.

If it is not practicable to store cull and surplus potatoes or use them immediately in the fresh form as feed, perhaps the next most feasible thing is to convert them into silage. In the form of silage, potatoes may be stored for at least one year. Potato silage has about the same palatability as corn silage, and it is approximately equal to corn silage in feed value on the dry weight basis. A number of methods have been followed (6). The potatoes may be either raw or cooked. They may also be mixed with grass, clover hay, alfalfa, or ground corn before being ensiled. The ensiling process may be conducted either in a tower or a trench silo. The trench silo method is apparently the most economical for large-scale operations. Potatoes are loaded into trucks, covered, steamed while on the trucks, and then transported to previously prepared trenches. After a trench has been filled, it is covered with soil or agricultural wastes, such as pea vines. During the summer of 1946, following small-scale experiments in

North Carolina (4) and Colorado (1) which demonstrated the feasibility of the method, about 300,000 bushels of potatoes were ensiled in northern California (3) by this process.

Dehydrated potatoes have been fed successfully to livestock. This material is comparable, if not quite equal, to corn in feed value. In several of the western states during hot, dry seasons, potatoes have been sliced or crushed and subsequently dried in the open air. Perhaps one of the more economical methods for drying potatoes is that practiced in 1946 on the concrete runways of airfields in the desert region of California. Potatoes were crushed with large mechanical equipment and left to dry in the hot, dry air. An alternative procedure of sun drying practiced in 1946 in Kern County, California, was to spread whole potatoes on a bed of straw and let them dry for three months. Another economical method of air-drying was used in North Dakota during the winter and spring of 1946-1947. Whole potatoes were spread on the ground to freeze and subsequently dehydrate. If it is not practicable to use air-drying because of climatic conditions, as much water as possible can be removed by pressing and then the press cake can be thermally dried. A plant was established in Grand Forks, North Dakota, recently to mechanically dewater and thermally dry cull potatoes for feed. During periods of potato surplus and grain shortage, potatoes have been dehydrated in cider mills and sugar beet plants for production of feedstuff and raw material for alcoholic fermentation. Experience has shown, however, that the mechanical and thermal dehydration of potatoes for production of feed and fermentation raw material is uneconomical unless the potatoes are obtained at a low cost and the product is sold at a relatively high price. By special arrangement with the United States Department of Agriculture, one plant is now dehydrating potatoes at the rate of 60 carloads (900 tons) per week. If conditions continue to be favorable for these operations, the cost of this plant may be amortized in one or two seasons.

It has been estimated by the Chemical Engineering and Development Division of this Laboratory that the cost of drying potatoes by an economical method which also reduces explosive hazards to a minimum is about $23.00 a ton of product containing 12 per cent moisture. In their improved process the potatoes are hammer-milled, mixed with dried product to reduce the moisture content to 40-45 per cent, and dried in a rotary steam-tube drier. The estimate for this process includes all costs except that of the potatoes and the selling cost of the product. If it is assumed that dehydrated potatoes have 0.9 the feed

value of corn and that corn is worth $1.00 a bushel, then, in order to compete, raw potatoes would have to be delivered at the dehydration plant at about $1.40 per ton, if the processor is allowed a return of 10 per cent on his investment. With corn at $2.00 a bushel, potatoes would be worth about $8.70 a ton. In several industrial applications, for example livestock feeding, starch production, alcoholic and certain other fermentations, and glucose sirup and dextrose sugar production, potatoes must compete with corn. Table 3 shows that dehydrated potatoes compare closely with corn in composition, with the exception that corn contains much more fat.

TABLE 3 *Typical analyses of potatoes and corn*

	Potatoes	Dehydrated Potatoes*	Corn
Moisture, per cent	78.9	10.0	10.8
Carbohydrate (mainly starch), (Per cent)	17.4	74.4	73.4
Protein, per cent	2.1	9.0	10.0
Fat, per cent	0.1	0.4	4.3

*Values obtained by assuming dehydrated potatoes contain 10 per cent moisture and computed from analysis of fresh potato without regard to the loss of protein during processing.

Corn dries out naturally on the cob to about 10 per cent moisture content, whereas potatoes must be transported to a processing plant and dehydrated at considerable expense to reduce the moisture content to a comparable percentage.

Alcohol Production. In Germany and in certain other European countries, potatoes have been used for many years as raw material for alcoholic fermentation. Varieties of potatoes having high-starch content were grown for this purpose, and the industry was controlled by the government and closely integrated with the potato industry.

A pilot plant for the conversion of cull potatoes into alcohol was established by the state of Idaho at Idaho Falls about ten years ago. After several years of operation, the plant was sold to a private company, which continued to operate for a while. Somewhat larger distilleries (with a capacity of about 5000 gallons of 190-proof alcohol per day each) were established at Newmarket, New Hampshire., in 1944 and at Caribou, Maine, in 1946 for the production of alcohol from potatoes. In this process, the potatoes are washed, cooked, and then cooled to the temperature at which malt converts the starch to sugar. The sugars are fermented to alcohol by yeast, and finally the alcohol is distilled from the mash.

One hundred pounds of potatoes will produce about one gallon of 190-proof alcohol. If industrial alcohol is produced, the distiller

must obtain potatoes at a relatively low price in order to operate profitably. If the distillery produces alcoholic beverages, a greater financial return is realized from the alcohol. The future for potato alcohol in this country seems to depend largely on whether potato liquors of unique flavor can be popularized. Since the Federal tax represents the main part of the cost of alcoholic beverages, the higher cost of potatoes as a raw material would be relatively unimportant. Consumer acceptance of blended whiskey containing potato alcohol, however, has not been particularly encouraging.

In addition to the three distilleries established specifically for fermentation of potatoes, many larger distilleries used dehydrated potatoes during 1943 and both fresh and dehydrated potatoes in 1946. While grain was scarce, distilleries were glad to receive potatoes as raw material, which was made available to them principally through the diversion program. With grain again available, however, there has been a tendency to return to corn. Several distilleries object to the use of potatoes on account of the higher material cost and the higher handling expense caused by the bulkiness of potatoes. However, potatoes may again be widely used for fermentation if corn prices remain unusually high and potato surpluses occur. A large proportion of the potato alcohol produced in 1947 has gone into industrial uses, little now being used for beverage purposes. Some potatoes recently have been fermented to butyl alcohol instead of ethyl alcohol.

Glucose Sirup and Dextrose Sugar. In Germany, The Netherlands, and certain other European countries where potatoes are the common source of starch, the production of potato sirup and dextrose sugar is a long-established industry. During World War II, supplies of cane and beet sugars in the United States became entirely inadequate. Sales of corn sugar increased from 459 million pounds in 1939 to 771 million pounds in 1942 (7). Sales of corn sirup increased from 1,142,000,000 pounds to 2,025,000,000 pounds, or 77.3 per cent during the same period (7). Even at this high rate of production, the available supply was far short of the demand, and sources of starch other than corn were sought to supplement the deficient supply of cornstarch for sirup.

In 1942, a plant was established at Lynden, Washington, by the Northwest Chemurgy Cooperative to produce sirup from potato starch. The process used by this organization in producing potato sirup has not been made public. In converting starch to sirup hydrochloric or sulfuric acid in low concentration is ordinarily used as catalyst, the reaction being carried out in about 10 to 15 minutes in an autoclave.

The resulting liquor, containing dextrins, maltose, and dextrose, is then neutralized, filtered, decolorized, and evaporated to sirup under reduced pressure.

Corn sirup generally sells for a fraction of a cent above the cost of the starch and at less than the cost of potato starch. It appears that in the absence of quality advantages potato sirup will have some difficulty in competing with corn sirup under normal conditions.

A few sugar beet factories which dehydrated surplus potatoes in recent years, during the off-season in the beet industry, converted by-product starch into sirup, but the considerable outlay of additional equipment required for outfitting a sugar beet factory to produce glucose sirup has discouraged further development along this line.

Disposition of Recent Potato Crops

The total potato production in 1946 was 475 million bushels, about 100 million bushels in excess of our normal requirements. Table 4 shows the disposition of this surplus.

Table 4 *Disposition of surplus potatoes from the 1946 crop. Stocks removed from the market by the government and diverted into various outlets.**

Outlet	Million Bushels
Alcohol production	29.2
Unharvested; deteriorated; lost in field storage	26.5
Livestock feed	18.3
Exported	11.3
Starch (mainly), flour, glucose	9.5
School lunches; direct relief to public institutions	3.2
Disposition undetermined (pending receipt of final reports)	0.5
Total	98.5

*Supplied through the courtesy of A. E. Mercker, Acting Chief, Potato Division, Fruit and Vegetable Branch, Production and Marketing Administration, United States Department of Agriculture, Washington, D. C.

Table 4 does not include figures on most of the potatoes processed in Idaho for starch, alcohol, feed, and other purposes; these were mainly culls purchased by processors directly from growers and shippers. In addition, an estimated five million bushels of potatoes were purchased outside of the Government program by distillers during the spring and summer of 1946.

Considerable criticism has been caused by failure to export more

surplus potatoes during the world food shortage. The greater weight and bulk of potatoes, as compared with grain of equivalent food value, and their perishability have discouraged exportation of fresh potatoes on a larger scale. On the other hand, foreign relief agencies have in general refrained from contracting for dehydrated potatoes because of their high cost.

Present Investigations

Investigations on potatoes are in progress at the Eastern Regional Research Laboratory along the following lines: (a) Conversion of potatoes into stable forms, for example, a dehydrated form or a concentrated hydrolyzate, which may be stored. Estimates based on batch operations at atmospheric pressure indicate that it will cost about $38.80 per ton of dry solids to prepare feed-grade potato "molasses" (acid-converted, neutralized, and concentrated), as compared with $26.20 per ton of dry solids for dehydrated potatoes. It is not known what the cost would be with a continuous process at higher temperature and pressure. (b) Improvement of the economic position of potato starch by technological advances in processing and by extension of uses, thereby encouraging greater diversion of potatoes into the starch industry. Studies of the fundamental physical properties of potato starch are being made which it is hoped will suggest new applications in which potato starch is superior to others. (c) Development of new industrial processes that will utilize the potato, for example, fermentation of saccharified potatoes to lactic acid, and possibly butylene glycol, acetone, and butanol. In such processes the mineral and protein contents of the potato might give it an advantage over some other carbohydrate bases, such as, corn starch, to which fermentation nutrients must be added. (d) Improved methods for storing fresh potatoes for later use as food or industrial raw material.

The general objective of the research in the National Potato Breeding Program, carried out by the Bureau of Plant Industry, Soils, and Agricultural Engineering in cooperation with about 25 State Agricultural Experiment Stations, is to develop new potato varieties that will combine as many of several desirable characteristics as possible, including high yield, disease resistance, good edible quality, and pleasing appearance of skin and flesh. Earlier experiments by the Department on imported varieties of European potatoes of high starch content were disappointing in that yields were poor and edible quality inferior. Further work in this field may eventually develop a potato variety of high starch content which will not only be better for table

use but also provide a more economical raw material for industrial utilization.

Outlook for Utilization of Potato Surpluses

In all probability no single industrial use will solve the problem of potato surpluses. Instead potatoes may continue to be used in several processes but more efficiently than in the past. There is the possibility, however, that an industrial process will be found in which the minor constitutents of the potato will give it some advantage over corn, wheat, and other high starch crops. If potatoes are expected to compete with corn on an equivalent starch basis, however, the potato industry and scientific workers must unite to make industrial processing of potatoes more profitable. The potato program under the Research and Marketing Act of 1946 may be expected to aid in solving problems of production, marketing, consumption, and utilization.

Closer grading of potatoes and state marketing agreements may result in better potatoes for the table stock market, an increase in consumption, and the reward of a higher selling price. Closer grading to improve quality will also produce a larger supply of culls for industrial use. It seems then that the potato industry might be able to enter operations in the processing field, with a higher price from better quality table stock potatoes helping to offset unfavorable economics. If no good use is made of the substandard potatoes, the alternative is dumping, which entails expense, is hazardous from the standpoint of spreading potato diseases, and is abhorrent to the American public, particularly because of starvation conditions in many parts of the world.

The widespread adoption of improved methods of storing potatoes to make them suitable for utilization over a longer period of time should be helpful in dealing with the surplus potato problem. More general practice of ensiling and air-drying potatoes will provide a way of preserving them for later use as feed without expensive processing. Establishment of potato starch and alcohol factories in regions of high potato production should be encouraged in order to provide outlets for the inevitable supply of cull potatoes and for the occasional surplus crops. In addition, the research now in progress on improved varieties, superior processing methods, and new outlets and applications should improve the position of the potato as an industrial raw material.

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THE PROTECTION OF THE PROPERTY OF THE POTATO BREEDER IN THE NETHERLANDS

DR. H. DE HAAN

Institute for Plant Breeding, Wageningen, Holland.

"What the inventor is to industry
that the plant breeder is to agriculture."

The above motto expresses the thought that the originators of new varieties render a service to society comparable to that done by inventors. The work of the plant breeder is on a par with that of the technical innovator in making the life of his fellow men more abundant.

The law in all civilized countries sees to it that the inventor derives a just profit from his labor; patent rights protect his work. The more the invention is applied, the larger the reward of the inventor. Authors and artists are also protected similarly by a copyright.

These legal measures satisfy a sense of justice and at the same time stimulate inventive activity and cause social progress. What labor and ingenuity they have encouraged! They have vigorously furthered the development of agricultural implements, motors, electric lamps, radios and of thousand other tools of modern civilization. They have enabled the creation of a great number of works of art. If patents and copyrights were abolished many gifted people would have to earn their living in another way, doing less important things.

Until recently a plant breeder who sold a handful of grain or a few tubers lost his ownership of the variety. Any one could increase and sell the stock without obligation to its originator. In some countries a regulation for the protection of the rights of the breeder have come into being. Visitors from abroad to our institute are always highly interested in the way the property of the plant breeder is safeguarded in the Netherlands. In this article I shall try to sketch the essential features of the protective measures.

In a commentary on the contents of the twenty-second "Descriptive List of Varieties of Field Crops 1947" the following statement is made concerning the supplying of seed and planting material in the Netherlands.

"Gradually the conviction has grown in the Netherlands that the breeder of new varieties performs a very important social function and his work has the right to be protected and supported by the Govenment. At the same time the opinion has gained ground that it is a matter of general interest that only first-rate seeds and planting material from the best varieties shall be confided to the soil."

These principles have been laid down and further worked out in the Plant Breeder's Decree put into operation in 1941 (Decree defining the legal position of the breeder and regulating the bringing into circulation seeds and planting material).

So far as field crops are concerned we may add the following:

(1) A new variety, whether produced by a foreign or a Dutch breeder, can be entered in the "Dutch Central Register of Varieties" which has the effect that the breeder (or the owner of his rights) obtains the "legal rights of the breeder" including, among other things, the right to compensation for certified seeds and seed potatoes grown by others.

(2) In the "Dutch Descriptive List of Varieties" are mentioned the varieties of special value to Dutch agriculture.

(3) Only the varieties included in the "Dutch Descriptive List of Varieties" are controlled by the General Netherlands Inspection Service for Seeds of Field Crops and for Seed Potatoes (N.A.K.) at Wageningen.

(4) Only certified seeds and planting material may be brought into circulation in the Netherlands; or, be exported.

In this way the best guarantee is given to the purchaser of Dutch seeds and planting material that only first-class merchandise is brought into circulation. This regulation affords at the same time an opportunity to give the breeder an adequate reward for his difficult and painstaking labor.

Two points may be of special interest in connection with the above general outline. How are the funds formed from which the breeder is paid? According to what scale are the payments calculated?

The breeder's compensation funds are managed by the N.A.K. They are obtained through a levy on seed produced from crops raised by growers who do not act on behalf of the breeder and who did not develop the variety (once, twice or more often grown seed). The

same holds for seed potatoes. It is logical that the contributions should be levied on the production by others of the breeders' varieties.

For potatoes the levy is f 0.03 (slightly more than one dollar f 1.— = 0.38) per kg. certified seed potatoes, but the compensations to the breeder of potato varieties are determined per hectar of certified seed potatoes according to the following system.

Number of Years That a Potato Variety Is on the Market	For the First 500 Hectares*	For the Second 500 Hectares	For the Next 2000 Hectares	For the Further Area of Certified Potatoes
	Per Hectare	Per Hectare	Per Hectare	Per Hectare
1-15 Years	f 12.50	f 10.—	f 5.00	f 1.—
16-25 Years	f 10.—	f 5.—	f 2.50	f 1.—
26 Years and More	f 5.—	f 2.50	f 1.—	f 1.—

The minimum compensation is f 500.— (about $190.) during the first five years. If a potato variety originates through a bud mutation this minimum is f 125.—, except for the variety Roode Eersteling for which the minimum is f 250.—

In case of bud mutations the compensation is one-fourth of the above-mentioned rate; for the variety Roode Eertseling the compensation is, however, one-half of the normal rate.

Varieties that have lost their importance and figure in the List of Varieties under the heading O (variety of minor importance, no longer described) are considered to belong to the class of 26 years or older.

For the 1941 harvests the compensations to potato-breeders or their assigns amounted to f 46758.51; for the harvest 1944 to f 73,952. As an example we specify for a few potato varieties the compensation paid in 1941.

Alpha	f 5966.95	Noordeling	f 2691.—
Bevelander	f 6147.50	Record	f 1655.87
Furore	f 6815.30	Triumph	f 4649.—
Gloria	f 1118.75	Ultimus	f 4922.75

The breeders of 8 new potato varieties received in 1941 the minimum amount of f 500.—

In case a private person owns the breeder's right of a variety (which often happens in the Netherlands), the allocation is simple, but if an employee of a cooperative or of a government institute has bred a variety, it will be necessary to stipulate by contract the sum to which he is entitled. In various cases the employees have received 10 to 15 per cent of the compensation.

As was shown in the beginning of this article the ascertaining of

*Hectare=2.471 acres.

the identity of new varieties for the Central Register, the testing of the cultural value for the List of Varieties, the crop inspection and the marketing of seeds and propagation material now have been co-ordinated in the Netherlands; the basis is the Plant Breeder's Decree, *viz.* the recognition of his proprietary rights. The protection of the breeder's ownership and the allocation of bonuses have had a favorable influence on the improvement of crop plants. More efficiently organized establishments, additional personnel, technical collaborators, better equipment, increase of the number of plant breeders have resulted.

The Plant Breeder's Decree, put in force in the Netherlands, relates also to varieties of foreign breeders, who are placed on an equal footing, provided in the country involved reciprocal arrangements exist. In every country where an inspection service for field crops exists, it is possible to find a formula to reward the breeder. (Wageningen, August, 1947).

A PROGRESS REPORT ON STUDIES OF THE EFFECTS OF VARYING THE PROPORTION OF LIME IN BORDEAUX MIXTURE FOR POTATO SPRAYING[1]

L. C. CALLBECK[2]

Since 1943 some investigational work has been conducted at the Dominion Laboratory of Plant Pathology at Charlottetown with bluestone-lime ratios in Bordeaux mixture. The results of these studies have proved so interesting that it is considered advisable to present them, in a short paper, at this time, and, although the studies have not been conducted on a scale sufficiently large for statistical analyses, the general trend in the control of late blight of potato is worth noting.

The use of low-lime Bordeaux mixtures was introduced as a necessity in 1943 when supplies of hydrated lime in Prince Edward Island were considered inadequate to maintain an intensive spray program if a severe epiphytotic developed during the season. The performance of three Bordeaux mixtures having the formulae 4-4-40, 4-3-40, and 4-2-40, together with three commercial fungicides, was studied. The variety Green Mountain was chosen for these experiments because of its susceptibility to attack by the late blight fungus, *Phytophthora infestans* (Mont) de Bary.

RESULTS FOR 1943

The first applications of the several fungicides were made on the 20th of July and the last on the 10th of September, the total number

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[1]Contribution Number: 912 of the Division of Botany and Plant Pathology.

[2]Assistant Plant Pathologist. Dominion Laboratory of Plant Pathology, Charlottetown, Prince Edward Island, Canada.

being seven. The sprays were applied with a tractor-sprayer combination, power take-off type, having four nozzles per row, and maintaining a delivery pressure of 275 pounds. Complete coverage of the foliage was reasonably assured by driving the sprayer both up and down the rows each day the applications were made. This technique is employed annually.

Some interesting data on foliage and tuber infection were collected and the results indicated the desirability of making more intensive studies. The data on foliage infection were obtained by making counts in four randomized blocks of twenty-five plants each, in each of the plots, and at four different dates. The results of these readings are shown in table 1, in which it is indicated that the 4-2-40 Bordeaux mixture gave the best control of the late blight disease.

TABLE 1.—*Late blight infected leaflets*, 1943.

Treatment	Percentage of Leaflets Infected				Increase for Period
	Aug. 18	Aug. 25	Sept. 2	Sept. 9	
4-2-40	0.2	0.6	1.5	3.0	2.8
4-3-40	0.4	1.3	2.2	3.9	3.5
4-4-40	0.2	0.9	1.5	3.9	3.7
Cop. Hydro 4¢	0.1	0.5	1.3	3.5	3.4
Coppesan	0.4	0.6	1.1	3.7	3.3
Perenox	0.1	1.3	3.5	4.7	4.6
Check[1]	17.0	60.0	95.0	100.0	83.0

[1]Percentage infection estimated.

RESULTS FOR 1944

Because the 4-2-40 Bordeaux mixture, in the 1943 test, had shown some superiority in late blight control compared with Bordeaux mixtures having a higher lime content, it was decided to reduce further the lime by one unit and a 4-1-40 Bordeaux mixture was included in the 1944 trials. This mixture, judged on the basis of tuber rot in the crops, gave the most effective control of late blight, as shown in table 4. Late blight became very severe during the latter part of the growing season and the check plots showed a loss of 23.8 per cent of the total yield because of late blight rot. Plots sprayed with 4-1-40 Bordeaux mixture showed a loss of only 0.5 per cent.

RESULTS FOR 1945

In 1945, the plan of plot arrangement was changed in a way calculated to place all fungicides on an equitable basis and under a more rigorous test. Unsprayed plots were alternated with the treated plots in

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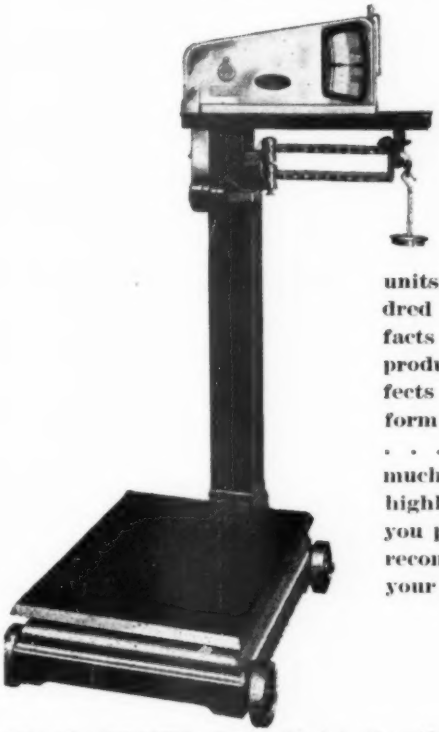

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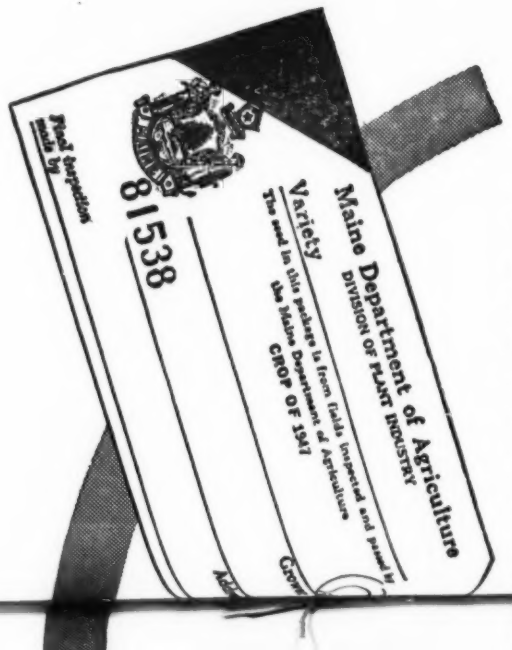

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each block of replicates so that the plants in each sprayed plot were given equal opportunity for infection. This plot arrangement was also employed in the 1946 experiment.

Late blight did not make its appearance until late in the growing season of 1945 and very few lesions were found in the testing area before the middle of September. At the end of the month a reading of the degree of foliage infection was made. On the 1st of October the temperature dropped to 25° F. at grass level, making further accurate counts impossible. The figures obtained at this examination are shown in table 2.

TABLE 2.—*Comparative numbers of late blight lesions, September 27, 1945.*

Treatment	Number of Lesions per Ten Plants	Deviation from Mean	
		Minus	Plus
4-1-40	0.0	24.0	—
4-2-40	2.0	22.0	—
4-3-40	2.5	21.5	—
4-4-40	10.0	14.0	—
Perenox	10.0	14.0	—
Copper-A	13.5	10.5	—
Dithane	62.0	—	38.0
Zerlate	92.0	—	68.0
Check	854.0	—	—
Mean of Sprayed Plots	24.0	106.0	106.0

The plots were harvested on October 10 and the tubers were graded and weighed after a four-week storage period. It was found that the plots on which 4-1-40 and 4-2-40 Bordeaux mixtures were used yielded approximately thirty bushels more per acre than the plots sprayed with 4-3-40 and 4-4-40 Bordeaux mixtures. Yields are shown in table 3. The low-lime Bordeaux mixtures gave the highest yields and the most effective control of late blight of the entire group of fungicides tested.

RESULTS FOR 1946

The season of 1946 was very dry and it was found necessary to disseminate spore suspensions over the experimental field four times to build up an epiphytotic. Yield differences among the treated plots were small but the low-lime Bordeaux mitxures once again showed a superiority in the control of late blight as indicated in table 4.

TABLE 3.—*Total yield of tubers.*

Treatment	Yield in Bushels per Acre			Deviation from Mean	
	1945	1946	Mean	Plus	Minus
4-1-40	291.7	306.6	299.1	9.4	—
4-2-40	286.3	296.5	291.4	1.7	—
4-3-40	259.8	310.2	285.0	—	4.7
4-4-40	257.6	304.3	281.0	—	8.7
Perenox	286.3	303.7	295.0	5.3	—
Dithane	277.5	295.9	286.7	—	3.0
Copper-A	258.9	—	—	—	—
Zerlate	275.1	—	—	—	—
Tri-Basic	—	303.7	—	—	—
Basi-Cop	—	286.1	—	—	—
Check	249.1	268.7	258.9	—	—
Mean of Sprayed Plots	274.2	300.9	289.7		

TABLE 4.—*Annual losses from late blight tuber rot.*

Treatment	Percentage of Total Weight Lost					
	1943[1]	1944[2]	1945[3]	1946[4]	Mean 1943-1946	Mean 1945-1946
4-1-40	—	0.5	0.2	0.3	0.3	0.3
4-2-40	0.1	4.5	0.2	0.6	1.4	0.4
4-3-40	0.1	9.0	1.2	0.6	2.7	0.9
4-4-40	0.8	12.7	0.4	1.1	3.8	0.8
Perenox	0.6	5.3	0.5	2.7	2.3	1.6
Copper Hydro 40	0.6	—	—	—	—	—
Coppesan	1.8	—	—	—	—	—
Dithane	—	—	3.3	1.5	—	2.4
Copper-A	—	—	0.5	—	—	—
Zerlate	—	—	4.8	—	—	—
Tri-Basic	—	—	—	1.0	—	—
Basi-Cop	—	—	—	2.4	—	—
Check	0.8	23.8	6.4	16.0	11.8	11.2
Mean of Sprayed Plots	0.7	6.4	1.4	1.3	2.1	1.1

[1]Seven applications; [2]seven applications; [3]five applications; [4]seven applications.

It is planned to use a larger number of replicates in the 1947 field tests in order that certain factors that may introduce errors, such as soil differences, will be greatly reduced.

SUMMARY

Field experiments conducted from 1943 to 1946 have shown that Bordeaux mixtures in which the amount of hydrated lime is not greater

than one-half the amount of copper sulphate are the most effective types of Bordeaux mixtures against late blight of potato, and plants so sprayed give the highest yields.

ACKNOWLEDGMENT

The suggestions of Dr. G. D. Steel, Principal of Prince of Wales College, Charlottetown, during the preparation of the manuscript are deeply appreciated.

SECTIONAL NOTES

INDIANA

Our weather conditions were good for the fall harvest. The potatoes matured nicely with very little skin damage. The Katahdin, Sebago, Chippewa, and Sequoia acreage is on the increase whereas Irish Cobbler and Rural varieties are losing ground.

We have some good yields again this year with a number of growers topping the 400-bushel mark during our dry season. The state production is almost 25 per cent below last year's crop and 30 per cent below the average with 3,700,000 bushels. This will mean approximately only a bushel of potatoes *per capita* when our average consumption is more than 2½ bushels. Our commercial growers are estimating on 35,000 for 1948. (Nov. 4).—W. B. WARD.

MAINE

Aroostook has not experienced the disastrous forest fires which have swept several areas of Maine, but the drought has seriously affected the potato industry. Because of the lack of water to generate power the county was placed on a rationing schedule. The county was divided and the two areas were given power on an alternating schedule, each two hours. This means that electricity is available every other two hours during the day. This has raised problems with shippers as all graders and hoists are electrically driven. Power is available from 11 P. M. to 7 A. M. for every one, so many shippers are operating on a night shift. Some shippers have purchased generators for their own use and these shippers are getting along well.

Despite the power shortage the shipments compare favorably with last year's shipments for this period.

Farmers expect another rise in the crop estimate for November but they are still confident that potatoes will bring a good price. The government has purchased about 1,671 cars at support prices. Practically all of these cars are being stored and may eventually affect the market.

The crop is coming out well, with field frost somewhat of a problem with individual farmers. All in all, this appears to be one of the best crops ever produced in Maine.

Sturges Dorrance, Advertising Counsel to Maine, was the speaker at the Aroostook County Farm Bureau annual meeting on the 5th of November. His report on the value of advertising in selling Maine potatoes was instructive. Many folks heard, for the first time, just how advertising has helped popularize Maine potatoes.

Harry Umphrey, of Presque Isle, is the new president of the Aroostook Farm Bureau.

To date shipments from Maine total 5,560 which is about 1,400 cars less than last year. Our shipments have slowed up because of the fact that many farmers have stored their potatoes and are waiting for the January support price, which promises to be higher. (Nov. 10).—VERNE C. BEVERLY.

MICHIGAN

Michigan has just completed harvesting the lightest crop in thirty years.

As we reported earlier in these Sectional Notes planting operations took place later than usual, but our growing conditions were so good that vine growths were normal. However, only local showers prevailed from late July until early September, with few of them in most places. Then frost came about the 20th of September. Instead of a good crop, which the vine growth would normally indicate before the frost, our yields were very disappointing.

Our certified seed is of very good quality but small in size. The acreage planted was about 25 per cent of normal, and our yields were reduced about 35 per cent. (Nov. 10).—H. A. REILEY.

NEBRASKA

The long drawn out Indian Summer finally came to an end the last week in October. Until that time the western Nebraska area had been favored by extremely pleasant and favorable harvest conditions. As a result, many growers delayed their harvest until that late date, in order to take advantage of all growing weather possible. This was an advantage that was necessary to offset the extremely late planting and unfavorable growing conditions during the summer.

Despite the late, favorable fall, the crop will fall short of average yields under both dry land and irrigated conditions. In most places, the dry land crop will be about one-fourth of what it was a year ago. This,

coupled with the fact that the potatoes are extremely small, and in some cases, emerged through the hard ground that caused mechanical injury, gives us a poor dry land crop. Irrigated conditions were somewhat more favorable, however. It is considered that irrigated yields will be below normal by about 25 or 30 per cent. Specifically, many dry land yields will be approximately 40 to 50 bushels, with very few running over 75. Irrigated yields will be around 250 to 300, whereas it is customary to have 100 bushels per acre more.

Because of the favorable fall, in fact, in some cases it was too warm, there were reports of potatoes arriving at terminal markets in a spotted condition. Generally this was caused by sun scald. However, that condition has been cleared up. Our later shipments have arrived in a good condition.

At this time, because of the erratic table stock market, a very few seed sales have been made. The opening prices on certified seed potatoes were at $3.50 per cwt. f. o. b. to the grower. Later sales will probably be at a higher price. Some shipments of certified seed are going out at this time, destined for the lower Rio Grande Valley of Texas. The majority of the shipments, however, will not go out until January, when seed will move into the other Gulf Coast States of Louisiana, Mississippi, Alabama, etc.

Because of the very good crop of wheat, sugar beets and beans, at this time it is difficult to say what the estimated acreage of the 1948 crop of potatoes will be. A further reduction in the acreage is anticipated. (Nov. 11).—MARX KOEHNKE.

NEW JERSEY

All of the commercial crop in New Jersey is now harvested and nearly all of it sold. A few thousand bushels of Green Mountains, Katahdins and Mohawks have been placed in storage for sale during the winter months. Seed growers are finishing their harvesting of "second croppers" and, because of the extremely dry weather during the growing season, the yields are very low.

The state goals for potatoes in 1948 were released by the P&MA in September and New Jersey was given the same goal as last year. Since that time the government has had to purchase increasing quantities of our production and P&MA is now requesting a reduction in the acreage of several early and intermediate states including New Jersey. At a recent meeting of the state committee the growers were of the opinion that New Jersey should not be requested to reduce its acreage unless the other states took an equivalent cut. The relatively large quantity pur-

chased by the government was in part caused by the large quantities of potatoes being offered for sale by other states during our normal marketing period. With average potato yields throughout the country showing substantial increases in recent years, the national acreage must be reduced in order to prevent the production of surplus potatoes. Our New Jersey growers are willing to take a proportionate cut in acreage but do not want to be unjustly treated. In addition to reducing the acreage New Jersey growers must extend their marketing season into the winter months and thus reduce the excess quantities of potatoes offered for sale during July and August. More adequate storage space is a partial answer to the problem of large government purchases and some New Jersey growers are planning to build such facilities. (Nov. 13, 1947)—JOHN C. CAMPBELL.

NEW YORK

The potato crop throughout up state New York was frozen down the night of the 22nd of September. Since that time we have had very dry weather and the crop is now harvested in much better condition than usual. The tuber color is bright, clean, and the size is good.

Because of the late planting and an early freezing, the yield was not high this year. It was probably the shortest growing season we have experienced in several years. However, with the medium-sized crop, we have no excessive sizes. Although we will have more than the usual amount of small ones this is not regarded as a serious disadvantage, since many of our growers are seed producers.

Seed producers are generally not only well pleased with the size but also with the appearance of their crop. Although the total crop will be light, we anticipate good prices which ought to balance this condition.

There seems to be a mild interest in marketing agreements, but to date the interest is to learn how they might function rather than the actual plan for setting up an agreement.

The table stock market is good at support levels or above. Some sales are now, during the latter part of October, being made at the November level.

Reports will soon be available on the performance of some of the new varieties. Preliminary indications show the Ontario to be living up to its reputation for scab-resistance and high yields. Some of the so-called Blight Immunes will now be called Blight Resisters. On the whole, they gave a good performance, both as to blight resistance and high yields. Some varieties will be eliminated within the next few years. Tetons were tried quite extensively with varying results. It is a heavy

setter and where they had plenty of moisture high yields were obtained. This variety is reported to be an excellent shipping potato and resistant to Ring Rot. (Oct. 29).—W. J. EVANS.

OREGON

Klamath Basin potato crop was harvested under favorable weather conditions. Our acreage was 16,000 as compared with 24,000 in 1946.

Our yields were reduced from 15 to 20 per cent, and our shipments are, generally, estimated to be under 60 per cent of last year.

There is a tendency for growers to store their potatoes for a later market. Shipments to date are rather light; about 50 per cent that of 1946.

Although our seed acreage has been reduced, the quality has improved compared with that of last year. (Nov. 5).—C. A. HENDERSON.

Our field inspections have been completed under our 1947 program for seed potatoes. We are just starting our bin inspections and certain acreages might be rejected due to certain troubles found in the bin. We now have field-test requirements before any Netted Gem seed can be tagged and these requirements must be met. Seed from all our Netted Gem lots has been planted in Southern California in connection with this program. We expect to make readings on these lots some time in January. Our foundation seed lots, which compose mainly the White Rose variety, will be planted in the greenhouses on the college campus at Corvallis. Here again, before eligible for our purple foundation tag, each lot must meet with the requirements for foundation seed.

The acreages that passed field inspections by varieties are as follows: Bliss Triumph, 10 acres; British Queen, 8; Burbank, 208; Calrose, 7; Chippewa, 2; Earliest of All, 32.9; Early Rose, 2.55; Epicure, 0.2; Gold Coin, 8; Great Scot, 1; Irish Cobbler, 1.5; Katahdin, 10; Netted Gem, 1,571.75; Pontiac, 0.75; Teton, trace; White Rose, 1,201.15 acres.—with a total acreage of 3,064.80.

In the Netted Gem variety we have 51.8 acres eligible for foundation tags and 1,519.95 acres eligible for the certified grade providing each makes its respective requirements. The White Rose acreages (528.95) are eligible for foundation based on field inspection and 672.2 acres have passed as certified. These two varieties are our leading ones at this time in connection with our foundation seed program. (Nov. 6).—H. E. FINNELL.

CANADA

A heavy white frost about the first of October killed most of the potato foliage in Prince Edward Island. Harvesting operations have been in full swing all month, with growers reporting fair to good or excellent yields. Bin inspections started on the 6th of October. Little or no blight, but considerable scab, has been present. Active shipping has been delayed as much as possible to allow tubers to harden.

Reports received from New Brunswick show that a total of 15,515 acres passed inspection this year. The main varieties included in this figure are Katahdin 9,984 acres; Green Mountain 3,061; Bliss Triumph, 1,439; Irish Cobbler, 665; Sebago, 231; White Bliss, 117; and Pontiac 10 acres. In Nova Scotia, a total of 1,206 acres passed inspection, the principal varieties being Katahdin, 574 acres; Bliss Triumph, 185; Irish Cobbler, 171; Green Mountain, 131; Sebago, 101; Warba, 16; Garnet Chili, 10; and Sequoia, 6 acres. The total acreage passing inspection in Ontario is 2,364; and the main varieties are as follows: Katahdin, 1,498 acres; Chippewa, 365; Irish Cobbler, 245; Green Mountain, 119; Sebago, 67; Rural New Yorker (Dooley), 45; and Warba, 13. British Columbia fields passing inspection totalled 2,270 acres, and the main varieties are Netted Gem, 1,422 acres; White Rose, 420; Green Mountain, 115; Warba, 91; Early Epicure, 65; Katahdin, 33; Columbia Russet, 14; Chippewa, 19; Wee McGregor, 13; and Burbank, 13. Reports for other provinces were included in the "Sectional Notes" for October. (Oct. 31).—W. W. KEENAN.

PROVINCE OF ONTARIO

The demands for potatoes continue to be keen with prices showing improvement. Large quantities are being moved by truck and there is an active movement of carload shipments from local centers. American buyers have purchased several carloads of Foundation A grade Katahdins at $2.25 per 75-pound bag at local shipping point. The quality of Ontario potatoes reaching markets has improved and many consumers are now giving preference to local products. Sales of pre-packaged potatoes have increased. Enforcement of Farm Products Grades and Sales Act has resulted in several convictions at various centers.

The Provincial record of 684 bushels per acre for yield was ·oken this year by three growers from Parry Sound District as follows: Fred Sohm, Magnetawan, 718 bushels per acre; C. H. Chapman, Nipissing, 694; and Frank Rick, Trout Creek, 693 bushels. The average for 21 contestants completing the Parry Sound District 500 Bushel Club was

460 bushels per acre, whereas the average for the first ten high contestants was 593 bushels. Seventeen similar clubs completed contests in 1947.

The annual survey for bacterial ring rot has now been completed with a number of cases less than one-half of a year ago. Most cases were trace infections probably caused by disease organisms spreading by used bags containing diseased seed.

The prices on Toronto market continue to be the lowest of any in the Province with quotations for Canada No. 1 grade Ontario potatoes Monday, November 10th, wholesale to retail at $1.75 to $1.90 per 75 lb. bag. Our prospects, however, look promising for a firm market. (Nov. 10).—R. E. Goodin.

WHAT'S AHEAD FOR THE POTATO INDUSTRY

Every one interested in the potato industry is concerned as to what is to happen after next year when the present price support plan is terminated. Various suggestions are being made concerning the procedures to adopt to maintain a sound industry. At the hearings before the Hope Committee, representatives from the different potato-growing sections were given an opportunity to present their recommendations.

At the meeting of the Hope Committee at Durham, New Hampshire, on October 13, the following statement was presented by Clifford G. McIntire of Maine. As Mr. McIntire points out, he spoke for himself and it is entirely possible that some of his fellow potato growers in Maine may not agree with his suggestions. He did, however, make a number of interesting suggestions to the committee. It would be helpful if other statements, presented to the Hope Committee, could be printed so that potato growers in different parts of the country could be acquainted with the thinking in competing areas.

TESTIMONY PRESENTED BY CLIFFORD G. McINTYRE OF PERHAM, MAINE, BEFORE HOUSE AGRICULTURAL COMMITTEE AT DURHAM, N. H., OCTOBER 13, 1947

Mr. Chairman, members of the Committee; I am speaking as a potato grower with my home being on a farm in Aroostook County, Maine. I am speaking for myself only, as I represent no organization or group of growers and I speak solely as a producer.

The potato industry in Maine represents an important part of the agriculture of the state. About 6,000 farm owners raise potatoes on a

commercial basis. The 1947 crop is estimated to total over 58,000,000 bushels or 16 per cent of the potato crop of the United States. In 1947, Maine planted 183,000 acres to potatoes and approximately 85 per cent of the acreage is located in Aroostook County. The potato growers of Maine have a capital investment in land farm improvements of more than $50,000,000, personal property, which is about wholly equipment, of $18,000,000, and an investment in the current crop, just now being harvested, of at least $36,000,000, a total capital investment of more than $104,000,000. The potato industry of Maine has made substantial financial gain over the past eight years, and at the present time farm real estate mortgage indebtedness is relatively low, however, increasing costs of production during the past few years have brought us to the point where the cost of producing the crop is at an all time high. In spite of substantial equities and savings on the part of individual farmers, credit facilities are used extensively in the production of each year's crop. It is my estimate that in producing the 1947 crop, over $16,000,000 have been borrowed by our potato growers, these loans being made by Production Credit Associations, commercial banks, Farm and Home Administration, private individuals and corporate organizations.

Irish potatoes are grown commercially in practically every state in the Union. With the importance of this industry to Maine farmers, I am sure you can appreciate that any long range policy for agriculture in this country is of vital concern to a potato grower in Maine. The business of producing high yields of the finest potatoes grown in the country has been our job for years. Nature has provided us with ideal soil and climatic conditions. However, nature and geography have made it essential that we stake our future almost solely on potatoes as the short season and distance to market seriously limit our opportunity for any material diversification of our farm income.

In the consideration of a long range policy for agriculture there are many problems of a national and international aspect that are beyond my comprehension. This world food problem has tremendous implications at the present moment. Our agricultural leaders at the national level are in a better position to evaluate the production capacity of American agriculture and the world needs than a small producer out in the country. The American farmer has given reasonable evidence of his ability to produce in supporting our war effort with limited facilities at his disposal, so, given adequate equipment, fertilizing materials and labor, I believe he can push even higher the production capacity of his farm. A healthy people is essential to a strong nation and as a producer I am interested

in helping to provide the consumer with potatoes as a part of this healthy diet.

The potato industry as a whole has experienced wide fluctuation of prices and income to farmers. It has not been alone in this respect and together with many other producers we have enjoyed prosperous years, and have struggled through the depths of depression. With agricultural income representing such an important part of our whole national economy, it seems to me that it is to the public interest that agriculture as a whole be maintained on a sound stable basis. Although the American farmer in general, and the Maine farmer in particular, prefer to think of themselves as self-reliant individualists, however, they realize, I believe, that their economic well-being is so closely interwoven with other farmers of the country and all phases of industry that they must look to sound over-all programs in order to assure their own well-being.

It is my opinion that a price support program is a legitimate part of a sound long-range program for the potato industry. The program should be based on a parity formula that includes farm labor as a factor in the cost of production. I believe that a support program for the potato industry at 90 per cent of parity promotes expansion within the industry, has a definite inflationary effect on land values and requires close control of the acreage to be planted. It is my opinion that any support program should be at a level which is below cost of production. I believe support at a "loss level" would promote better farm practices, and reward personal initiative. It would take out of production land not adapted to potatoes and in effect would tend to control the acreage without acreage allotments. The proportion of parity price at which support would be made effective could be varied from year to year as increase of production was needed, being lowered if surplus seemed apparent. The support program should provide for handling the surplus by diversion of low grades to by-product use and shipment of better grades for export. When surpluses exist, special emphasis should be placed on marketing only the most desirable portion of the crop in order that the consumer might benefit in having a quality product available. In my opinion any support program should be made effective at the grower level, permitting the consumer to buy at a price that reflects the supply of potatoes available. In periods of surplus and in periods of normal supply, off-grade potatoes should be directed to by-product use. We have in Maine, by-product facilities to handle 400,000 bushels of potatoes per week. This seems like a substantial quantity but at times in the past, these facilities have hardly been adequate. Although I believe the processing of off-grade potatoes should be handled by these private facilities to their maximum capacity,

however, in order to assure the producer of maximum return for this portion of his crop and to assure full use of any surplus which might exist, it might be found advisable for the government to have available a stand-by plant for industrial alcohol located in the central part of the producing area.

Supplementing the support program, I believe a great deal more emphasis should be placed on research in marketing and by-products. We should continue our research in production and farm management. We need maximum yields per acre to reduce our cost per unit of production. However, the means of getting the best product possible to the consumer in a manner that encourages more full use of our product is a field of research that has had far too limited attention in the past. This research should be more than the assembling of figures. It means new designs in farm equipment, new designs in warehouses, new designs in graders, new designs in transportation facilities and new methods of packaging and distribution to the consumer. Full use of this type of research coupled with a price support program below the cost of production will, I believe, remove much of the threat of surpluses in our industry.

With our own future at stake and our responsibility to other peoples in our world economy, we must place more emphasis than ever before on soil conservation and soil reserves. The educational facilities of the Extension Service, the work of the Production and Marketing Administration, the extension of agricultural credit, and phases of Federal, State and County agricultural activity should emphasize anew the need of saving our soil, timber and other resources of our farms. In my opinion the establishing of a soil-fertility reserve merits very careful study. In Maine it might logically develop into a substantial improvement especially in our timber reserves, which have been seriously depleted. The Soil Conservation Service has made substantial progress in the intensively cropped areas of Aroostook. There is a great deal more work to be done. Their program of strip-cropping and contour farming is a radical change from our large fields and straight rows. However, the results are now generally accepted and the Soil Conservation District in the county has agreements on hand to cover two full years of work, with other farmers asking for assistance.

With the equipment which is now becoming available, the labor problem in the potato industry in Maine is well in hand, except at harvest time. We have little or no problem in regard to displaced farm labor. Our seasonal labor problem at harvest time is serious and it has been only by the assistance of labor imported from the south central states and Canada that we have been able to harvest our crop successfully dur-

ing the past four years. Special emphasis is needed at once on research leading to the design of a practical potato harvester. Until that machine is available we shall need to import, as we have this year, at least 7,000 workers to assist in the harvest. This fall all of our help has been imported from Canada. Negotiations for this labor must of necessity be carried on between the two governments involved. I believe a substantial portion of the cost should be borne by the farmers.

In conclusion, as a potato grower from Maine, I believe we should make an effort to perfect our farm programs along lines that promote personal initiative and reward diligent effort. I believe we should have a program that encourages good farm practices but does not retain poor land or poor farmers in commercial production at government expense, a program that conserves our agricultural resources and assists the farm operator to be a farm owner and the best farmer possible, producing the best quality crops at lowest costs, getting a maximum part of that production to the consumer and one that promotes maximum use of that product by the consumer. I believe we must have a program that encourages young men to continue on our farms. Credit facilities must be sound, conservative in good times and courageous when operating margins are narrow. We need government assistance in coordinating these farm programs but administration should be at state and county levels, guided by farmers in local communities.

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PROGRAM OF THE ANNUAL MEETING OF THE POTATO ASSOCIATION OF AMERICA

December 28, 1947 to December 31, 1947

Chicago, Illinois

President, MARX F. KOEHNKE, *Nebraska Certified Potato Growers*, Alliance, Nebr.

Secretary, REINER BONDE, *University of Me.*, Orono, Me.

Sunday Afternoon, December 28; Palmer House, Private Dining Room 9. 1:30 P. M. Society Session—Seed Certification Problems.

HENRY M. DARLING, *Presiding*

Report of Potato Breeding Committee for 1947. G. H. RIEMAN.

Progress of Virus and Bacterial Disease Investigations in 1947. JAS. H. JENSEN.

Insect Investigations in 1947. ROSCOE E. HILL.

Round Table Discussion: *Report on Bacterial Ring Rot Survey.*

Miscellaneous Problems.

Monday Morning, December 29; Palmer House, Private Dining Room 9. 9:00 A. M.—Society Session.

MARX F. KOEHNKE, *Presiding*

1. *Report of Potato Research Committee.* (20 min.) E. V. HARDENBURG, Cornell University, Ithaca, N. Y.
2. *Resistance of New Potato Varieties to Common Scab in Wisconsin.* (10 min.) G. H. RIEMAN, University of Wisconsin, Madison, Wis.
3. *Report of Harvest, Transportation and Storage Committee.* (20 min.- J. M. LUTZ, U. S. Hort. Field Station, Meridian, Miss.
4. *The Effect of Chemical Vine Killers on the Quality and Yield of Red McClure and Triumph Potatoes.* (12 min.) R. KUNKEL and A. M. BINKLEY, Colorado A & M College, Ft. Collins, Colo. W. C. EDMUNDSON, U. S. Potato Field Station, Greeley, Colo.
5. *The Relationship between Maturity, Yield, Color and Cooking Quality of Bliss Triumph Potatoes.* (12 min.) R. KUNKEL, L. A. SCHALL and A. M. BINKLEY, Colorado A & M College, Ft. Collins, Colo.
6. *The Testing of Varieties as It Applies to a Potato Improvement Program.* (12 min.) E. J. WHEELER, Michigan State College, E. Lansing, Mich.
7. *Combining Value of Parents for Resistance to Common Scab.* (15 min.) F. A. KRANTZ and CARL J. EIDE, University of Minnesota, St. Paul, Minn.

8. *Pollen Sterility in Solanum demissum-tuberosum hybrids.* (5 min.) PAUL YAGYU and HUMBERTO GANDARILLAS, University of Minnesota, St. Paul, Minn.

9. *Relationship of Pressure Tester Readings to Specific Gravity in the Potato.* (10 min.) O. C. TURNQUIST, University of Minnesota, St. Paul, Minn.

10. *Plants from Fasciated Sprouts of a Potato Tuber.* (5 min.) W. A. OITTO, University of Minnesota, St. Paul, Minn.

11. *Nomenclature, Pedigrees and Breeding Programs.* (10 min.) DONALD REDDICK, Cornell University, Ithaca, N. Y.

12. *Louisiana Releases Three New Varieties of Potatoes.* (10 min.) JULIAN C. MILLER, Louisiana State University, Baton Rouge, La.

Monday Afternoon, December 29, Palmer House, Private Dining Room 9.

1:30 P. M. Society Session—Business Meeting.

3:00 P. M. Presentation of Papers.

MARX F. KOEHNKE, *Presiding*

1. *Influence of Thiourea on Set and Size of Potato Tubers.* (12 min.) (Lantern) ORA SMITH, J. H. ELLISON and FRED McGOLDRICK, Cornell University, Ithaca, N. Y.

2. *Relation of Potassium and Magnesium to Potato Yields.* (12 min.) (Lantern) ORA SMITH, FRED McGOLDRICK and J. H. ELLISON, Cornell University, Ithaca, N. Y.

3. *Carlot Storage and Shipping Tests with Nebraska Triumph Seed Potatoes for Southern Midwinter Planting.* (20 min.) H. O. WERNER, University of Nebraska, Lincoln, Nebr.

4. *Some Experience with Shell Cooled Bins for Storing Seed Potatoes.* (15 min.) H. O. WERNER, University of Nebraska, Lincoln, Nebr.

Monday Evening, December 29, Palmer House, Club Floor Room 18.

8:00 P. M.—Society: Smoker and Round Table Discussion.

O. D. BURKE — W. N. KEENAN, *Presiding*

Tuesday Morning, December 30, Stevens Hotel, South Ballroom 1.

9:00 A. M. Joint Session with American Phytopathological Society.

O. D. BURKE, *Presiding*

1. *Forecasting Late Blight in Eastern Virginia in* 1917. (12 min.) (Slides) HAROLD T. COOK, Virginia Truck Experiment Station, Norfolk, Va.

2. *Some Histological Features of Potato Stem Necrosis Associated with Actinomyces scabies.* (15 min.) (Lantern) W. J. HOOKER, Iowa State College, Ames, Iowa.

3. *Evidence of Parasitic Activity of Actinomyces scabies on Seedling Roots.* (15 min.) (Lantern) W. J. HOOKER and J. E. SASS, Iowa State College, Ames, Iowa.

4. *A Virus Causing Internal Necrosis in White Rose Potato.* (15 min.) (Lantern) JOHN W. OSWALD, University of California, Davis, Cal.

5. *Chemicals for Control of the Golden Nematode of Potatoes.* (5 min.) (Lantern) C. G. SCHMITT, Boyce Thompson Institute, Yonkers, N. Y.

6. *Potato Vine Killers.* (12 min.) (Lantern) WM. G. HOYMAN, N. D. Agricultural College, Fargo, N. D.

7. *A Comparison of Corynebacterium sepedonicum Inocular from Resistant and Susceptible Potato Varieties.* (12 min.) (Lantern) G. H. STARR and W. A. RIEDL, University of Wyoming, Laramie, Wyo.

8. *Indicator Plants for Studies with the Leaf Roll Virus of Potatoes.* (15 min.) (Slides) HUGH C. KIRKPATRICK, Cornell University, Ithaca, N. Y.

9. *A Comparison of Chemical Tests with the Ultraviolet Technique in Testing Potatoes for Virus Content.* (15 min.) (Lantern) J. G. McLEAN, Kern County Seed Potato Assn., Bakersfield, Cal. ROBERT KUNKEL and GEORGE LANE, Colorado A & M College, Ft. Collins, Colo.

10. *Physalis angulata* (Ground Cherry) *an Indicator for the Potato Leaf Roll Virus* (10 min.) CHAS. HAVEY and REINER BONDE, University of Maine, Orono, Me.

11. *Potato Spraying in Maine for the Control of Diseases.* (10 min.) REINER BONDE, University of Maine, Orono, Me.

12. *Some Fundamental Things We Do Not Know about Virus Diseases of Potatoes.* (12 min.) E. L. WALDEE, Utah State Agricultural College, Logan, Utah.

Tuesday Afternoon, December 30, Palmer House, Private Dining Room 9.

1:30 P. M.—Society Session.

GEORGE M. LIST, *Presiding*

1. *Fertilizer and Culture Studies in 1947.* (20 min.) JOHN BUSHNELL, Ohio Agricultural Experiment Station, Wooster, Ohio.

2. *The Effect of Leafhopper Control with DDT Dust on Length of Growing Season, Quality and Yield of Seventeen Potato Varieties.* (15 min.) (Lantern) M. B. LINN, J. W. APPLE and C. Y. ARNOLD, University of Illinois, Urbana, Ill.

3. *Results of the 1947 National Cooperative Potato Spray Fungicide Experiment.* (15 min.) W. F. BUCHHOLTZ *et al*, State College of Agriculture, Ames, Iowa.

4. *Soil Fertility Investigations with Potatoes in Wisconsin.* (12 min.) K. C. BERGER, University of Wisconsin, Madison, Wis.

5. *The Effect of Temperature, Moisture and Nitrogen on the Development of Leaf Roll Symptoms in the Irish Potato.* (12 min.) M. W. FELTON, Nebr. Certified Potato Growers, Alliance, Nebr.

6. *The Development of Stem End Discoloration in Bliss Triumph Potatoes Held in Warm Storage.* (12 min.) M. W. FELTON, Nebr. Certified Potato Growers, Alliance, Nebr.

7. *Promising New Chemicals for the Control of Insects and Diseases.* (10 min.) JOHN C. CAMPBELL, N. J. Agricultural Experiment Station, New Brunswick, N. J.

8. *The Effect of Different Rates of Application of 2-4D on the Yield of Potatoes.* R. H. BRADLEY and N. K. ELLIS, Northern Indiana Muck Crops Experiment Station, North Liberty, Ind.

9. *Results from Spraying and Dusting Potatoes.* 12 min.) R. L. POST and WAYNE J. COLBERG, N. D. Agricultural College, Fargo, N. D.

10. *Use of Certain New Materials in the Control of Potato Insects in Michigan.* (10 min.) W. F. MOROFSKY and J. H. MUNCIE, Michigan State College, East Lansing, Mich.

11. *The Effect of New Insecticides on Potato Production in Minnesota.* (10 min.) A. A. GRANOVSKY, University of Minnesota, St. Paul, Minn.

12. *Studies on the Host Range of the Golden Nematode of Potatoes Heterodera rostochiensis.* (8 min.) (Projector) W. F. MAI and B. F. LOWNSBERY, JR., Cornell University, Ithaca, N. Y.

Wednesday Morning, December 31, Palmer House, Private Dining Room 17.

9:00 A. M. Joint Session with American Society for Horticultural Science.

W. N. KEENAN, *Presiding*

1. *Chemical Control of Weeds in Potatoes.* (12 min.) ORA SMITH, J. H. ELLISON and FRED McGOLDRICK, Cornell University, Ithaca, N. Y.
2. *Effect of Sprout Retardant on Seed Potatoes.* (10 min.) ORA SMITH, J. H. ELLISON and FRED McGOLDRICK, Cornell University, Ithaca, N. Y.
3. *Effects of Spraying a Sprout Inhibitor on Potato Plants in the Field.* (12 min.) J. H. ELLISON and ORA SMITH, Cornell University, Ithaca, N. Y.
4. *Killing Potato Vines.* (10 min.) FRED McGOLDRICK and ORA SMITH, Cornell University, Ithaca, N. Y.
5. *The Effects of Plowing and Discing Soils on the Subsequent Yields of Tomatoes, Muskmelons and Potatoes.* (10 min.) E. P. BRASHER, University of Delaware, Newark, Del.
6. *The Effect of Variety and Harvest Date on Yield and Specific Gravity of Alaska Grown Potatoes.* (15 min.) Z. M. FINEMAN, Agricultural Experiment Station, Palmer, Alaska.
7. *A Mutation for Tuber and Plant Characters in the Russet Burbank Potato.* (10 min.) Z. M. FINEMAN, Agricultural Experiment Station, Palmer, Alaska.
8. *Further Studies on the Use of Sprout-Inhibiting Chemicals for Seed Potatoes.* (10 min.) HUMBERTO GANDARILLAS and R. E. NYLUND, University of Minnesota, St. Paul, Minn.
9. *Preliminary Studies on the Value of Leaf Analysis of Potato Growth on a Low-Nitrogen Soil.* (10 min.) R. E. NYLUND, University of Minnesota, St. Paul, Minn.
10. *Effect of Location and Date of Planting on Yield and Grade of Certain Varieties of Potatoes.* (10 min.) (Slides) A. J. PRATT, W. C. Kelly and G. F. SOMERS, Cornell University, Ithaca, N. Y.
11. *Yield and Grades of Blight Resistant Potatoes Grown in 20 Different Locations in New York State.* (10 min.) (Slides) A. J. PRATT, Cornell University, Ithaca, N. Y.
12. *The Life Cycle of Potato in Relation to Testing for Yields.* (20 min.) (Lantern) T. H. HAWKINS, Kern County Seed Potato Assn., Bakersfield, Cal.

All members of the Potato Association of America, planning to attend the meetings in Chicago, December 28 through 31, are urged to register with the AAAS. The registration fee helps to defray part of the expense attendant with conducting meetings, payment of room space, and many other necessary expenses. The registration fee entitles each registrant to a copy of the general program, a convention badge, and special descriptive pamphlets furnished by local committees. In addition, the registrant will be listed in the visible directory available for inspection 24 hours a day. The registration fee is $2.00 for members, and $3.00 for non-members. Advance registration may be made until December 10 by sending the fee to the following address: American Association for the Advancement of Science, 1515 Massachusetts Avenue, N. W., Washington 5, D. C.

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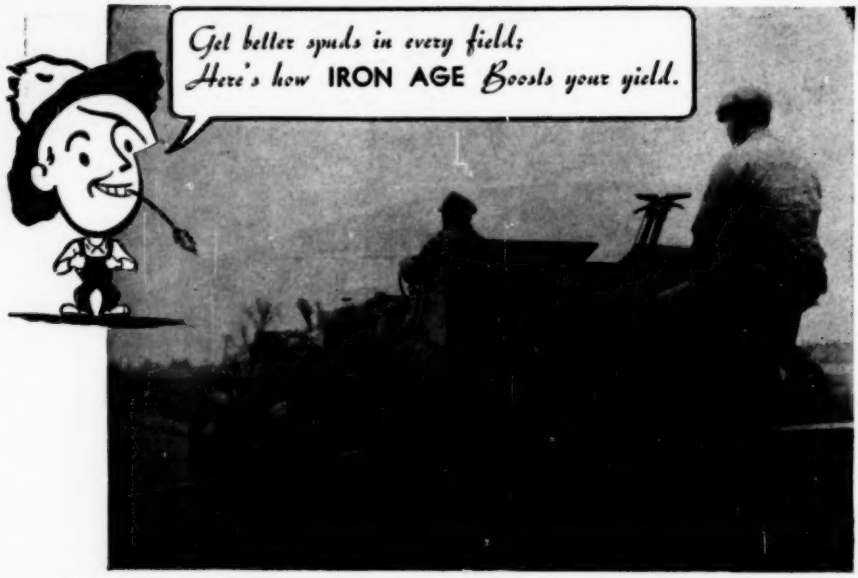

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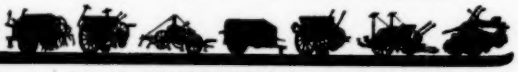

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